THE PARIS AGREEMENT AND CLIMATE GEOENGINEERING GOVERNANCE
THE NEED FOR A HUMAN RIGHTS-BASED COMPONENT

WILLIAM C.G. BURNS
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TABLE OF CONTENTS

iv About the ILRP
iv About the Author
1 Acronyms and Abbreviations
1 Symbols
1 Executive Summary
2 Introduction
3 Overview of Climate Geoengineering
17 The Application of Human Rights to Climate Geoengineering
22 Operationalizing Human Rights Protections under the Paris Agreement in the Context of Climate Geoengineering
32 Conclusions
34 About CIGI
34 CIGI Masthead
ABOUT THE ILRP

The International Law Research Program (ILRP) at CIGI is an integrated multidisciplinary research program that provides leading academics, government and private sector legal experts, as well as students from Canada and abroad, with the opportunity to contribute to advancements in international law.

The ILRP strives to be the world’s leading international law research program, with recognized impact on how international law is brought to bear on significant global issues. The program’s mission is to connect knowledge, policy and practice to build the international law framework — the globalized rule of law — to support international governance of the future. Its founding belief is that better international governance, including a strengthened international law framework, can improve the lives of people everywhere, increase prosperity, ensure global sustainability, address inequality, safeguard human rights and promote a more secure world.

The ILRP will focus on the areas of international law that are most important to global innovation, prosperity and sustainability: international economic law, international intellectual property law and international environmental law. In its research, the ILRP is attentive to the emerging interactions between international and transnational law, indigenous law and constitutional law.

ABOUT THE AUTHOR

William C.G. Burns is a CIGI senior fellow with the ILRP. Until recently, he served as director of the Energy Policy & Climate Program at Johns Hopkins University, and now serves as co-director of the Forum for Climate Engineering Assessment, a scholarly initiative of the School of International Service at American University in Washington, DC. He also serves as the co-chair of the International Environmental Law Committee of the American Branch of the International Law Association.

William is the former president of the Association of Environmental Studies and Sciences, as well as co-chair of the International Environmental Law interest group of the American Society of International Law. Prior to becoming an academic, William served as assistant secretary of state for public affairs for the State of Wisconsin and worked in the non-governmental sector for 20 years, including as executive director of the Pacific Center for International Studies, a think tank that focused on implementation of international wildlife treaty regimes, including the Convention on Biological Diversity and International Convention for the Regulation of Whaling.

William has published more than 75 articles in law, science and policy journals and has co-edited four books. His current areas of research focus are: climate geoengineering; international climate change litigation; adaptation strategies to address climate change, with a focus on the potential role of microinsurance; the effectiveness of international treaty regimes to conserve cetaceans; and how to effectively operationalize the precautionary principle in international environmental treaty regimes. William holds a Ph.D. in international environmental law from the University of Wales-Cardiff School of Law.
EXECUTIVE SUMMARY

There has been growing recognition in the past decade at both the international and domestic levels of the potential ramifications of climate change for the exercise of human rights. Even more recently, the locus of concern has expanded to include the human rights implications of response measures to confronting climate change. The newly adopted Paris Agreement includes language that calls on its parties to consider, respect and promote the protection of human rights when taking actions to address climate change. However, the agreement fails to suggest specific means to operationalize this mandate.

This paper suggests a framework for achieving the objective of protecting human rights in the context of climate change response measures. It focuses on one suite of emerging potential measures that fall under the general rubric of “climate geoengineering,” which is defined as efforts to effectuate large-scale manipulation of the planetary environment through technological options in order to counteract the manifestations of climate change. The paper suggests that the parties to the Paris Agreement utilize a human rights-based approach (HRBA) as a framing mechanism to ensure that the potential human rights implications of climate geoengineering options are assessed in the policy-making process moving forward. Such an approach may help to ensure that any potential negative ramifications of climate geoengineering options on the human rights interests of the world’s most vulnerable peoples are taken into account and minimized. Moreover, this analysis might help us to flesh out more broadly the contours of the new human rights language in the Paris Agreement.
INTRODUCTION

In the past decade, there has been increasing recognition in both the human rights and climate change communities of the profound, and largely adverse, impacts that climate change may have on the exercise of human rights. More recently, the ambit of concern has expanded to the potential impacts that *response measures* to climate change might have on human rights. For example, at the 16th Conference of the Parties (COP) to the UNFCCC, a resolution was adopted providing that the parties “should, in all *climate change related actions*, fully respect human rights.”

The Kyoto Protocol’s Adaptation Fund Board, in its Environmental and Social Policy guidelines, also provides that “Projects/programmes supported by the Fund shall respect and where applicable promote human rights.” Human rights bodies have similarly emphasized the need to respect human rights when addressing the threat of climate change. In terms of human rights institutions, the UN’s Office of the High Commissioner for Human Rights (OHCHR) in 2009 emphasized that “human rights standards and principles should inform and strengthen policy measures in the area of climate change.”

Most recently, in December 2015, the parties to the UNFCCC adopted the text of the Paris Agreement, a legal instrument designed to respond to “the need for an effective and progressive response to the urgent threat of climate change.” As the UNHRC recently observed, “the Paris Agreement is the first climate agreement, and one of the first environmental agreements of any kind, to explicitly recognize the relevance of human rights.” Its preambular language provides: “Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity.”

It is laudable that the drafters of the Paris Agreement recognized that programs and actions to address climate change can have human rights implications and that every effort should be made to ameliorate such impacts. However, as Basil Ugochukwu recently observed, there is an immediate need to translate this provision “in ways that integrate human rights into practical actions in specific climate change policies.”

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3 *The Cancun Agreements*, supra note 1 at para 8 [emphasis added]. While not explicitly referring to human rights impacts, the Kyoto Protocol to the UNFCCC includes concordant language, providing that industrialized countries should strive to “minimize adverse social, environmental and economic impacts on developing country Parties” in terms of mitigation response measures. Kyoto Protocol to the United Nations Framework Convention on Climate Change, 10 December 1997, 2303 UNTS 148, 37 ILM 22 art 3(14) (entered into force 16 February 2005) [Kyoto Protocol].

4 Kyoto Protocol, supra note 3.


7 UNFCCC, COP, Paris Agreement to the United Nations Framework Convention on Climate Change, 12 December 2015, Dec CP.21, 21st Sess, UN Doc FCCC/CP/2015/L.9, online: <unfccc.int/resource/docs/2015/cop21/eng/19901.pdf> [Paris Agreement].

8 Ibid, Preamble.


10 Paris Agreement, supra note 7, Preamble.

11 Basil Ugochukwu, *Climate Change and Human Rights: How? Where? When?*, CIGI, CIGI Papers No. 82, 27 November 2015 at 9. See also International Human Rights Law Clinic, Miller Institute for Global Challenges and the Law, University of California, Berkeley, School of Law & Center for Law & Global Justice, University of San Francisco, School of Law, “Protecting People and the Planet” (December 2009) at 7, online: <https://repositories.lib.utexas.edu/bitstream/handle/2152/7464/Protecting_People_and_the_Planet-Berkeley.pdf?sequence=2&isAllowed=y>.
This paper seeks to develop a framework for operationalizing the Paris Agreement’s human rights language in the context of an emerging potential response to climate change, a suite of technological options denominated as “climate geoengineering.” It is hoped that this exercise may help to inform efforts to develop guidelines for considering the human rights implications of other climate-related response measures in the future, including in the context of mitigation and adaptation.

Climate geoengineering is defined by the United Kingdom’s Royal Society as “the deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change.” As a number of commentators have noted, climate geoengineering could prove to be the most imposing global governance challenge of the next few decades. This is primarily because it could create both winners and losers in terms of its impacts. While this paper agrees with commentators who have expressed the need for the establishment of a comprehensive international governance framework for climate geoengineering, fleshing out its contours is beyond the scope of this paper. Rather, the purpose here is to suggest that a human rights-based approach may constitute a critical component in addressing intrinsic issues of equity and justice that would necessarily arise should the world community opt to proceed down this path. In developing this argument, this paper provides an overview of climate geoengineering options; discusses the potential human rights implications of climate geoengineering, including within the context of the Paris Agreement; and develops a human rights-based approach to operationalizing the human rights provisions of the Paris Agreement in the context of climate geoengineering options.

**OVERVIEW OF CLIMATE GEOENGINEERING**

**The Exigency for Climate Geoengineering**

The Paris Agreement establishes the objective of “[h]olding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels...” However, the emissions reduction pledges made by the parties to the UNFCCC to date, denominated as Intended Nationally Determined Contributions (INDCs) prior to the Paris Agreement and termed Nationally Determined Contributions in the agreement, are wholly inadequate to meet this goal. Indeed, the globe is currently on track for temperature increases between 2.6 and 3.7°C by 2100, with even much higher temperatures over the course of centuries.

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17 Paris Agreement, supra note 7, art 2(1)(a).

18 See UNFCC, Report of the Conference of the Parties on its nineteenth session, held in Warsaw from 11 to 23 November 2013, Dec 1/CP.19 Further advancing the Durban Platform, UN Doc FCCC/CP/2013/10/Add.1 at para 2(b), online: <unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf> [Durban Platform]; UNFCC, INDCs as communicated by Parties, online: <www.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>.

19 Paris Agreement, supra note 7, art 4(2).

20 Joeri Rogelj et al, “Paris Agreement Climate Proposals Need a Boost to Keep Warming Well Below 2°C” (2016) 534 Nature 631 at 634; Climate Action Tracker, “Paris Agreement: stage set to ramp up climate action” (12 December 2015), online: <climateactiontracker.org/news/257/Paris-Agreement-stage-set-to-ramp-up-climate-action.html>; World Resources Institute, “Why are INDC Studies Reaching Different Temperature Estimates?” (2015), online: <www.wri.org/blog/2015/11/insider-why-are-indc-studies-reaching-different-temperature-estimates>. It should be emphasized that the Paris Agreement does provide for a “global stocktake” every five years “to assess the collective progress towards achieving the purpose of this Agreement and its long-term goals,” with an eye to enhancing domestic and international commitments to meet the agreement’s overarching objectives, if necessary; Paris Agreement, supra note 7 at art 14. While this provision could help the parties to avoid passing the 2°C threshold, this would require strengthened commitments prior to the agreement entering in force and more ambitious long-term commitments; Wolfgang Obergassel et al, Phoenix from the Ashes — An Analysis of the Paris Agreement to the United Nations Framework Convention on Climate Change (January 2016), online: Wuppertal Institute for Climate, Environment and Energy <wupperinst.org/uploads/tx_wupperinst/submissions/indc/Submission%20Pages/submissions.aspx>.

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These references are taken from the text and are not explicitly cited in the provided natural text.
and millennia beyond.\textsuperscript{21} Temperature increases of this magnitude could have extremely serious implications for both natural ecosystems and human institutions.\textsuperscript{22}

The spectre of climatic impacts of this magnitude has led to increasing recent interest in climate geoengineering options. Climate geoengineering proposals date back to the 1830s.\textsuperscript{23} Yet, until the past decade, geoengineering was viewed as “a freak show in otherwise serious discussions of climate science and policy.”\textsuperscript{24} However, the feckless response of the world community to climate change has transformed climate geoengineering from a fringe concept to a potentially mainstream policy option.\textsuperscript{25} Within the last decade, committees in both the US Congress and UK Parliament have conducted hearings on climate geoengineering and called for government-funded research programs.\textsuperscript{26} In the case of the UK House of Commons, Science and Technology Committee, a recommendation was tendered for development of a regulatory framework.\textsuperscript{27} Moreover, two international regimes, the Convention on Biological Diversity and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, have responded to ocean-based geoengineering research initiatives by issuing regulatory guidelines for prospective research.\textsuperscript{28}

On the scientific side of the equation, small research programs on geoengineering options have been launched in several regions of the world, including the United States,

\begin{itemize}
\item \textsuperscript{21} Carolyn W Snyder, “Evolution of Global Temperature Over the Past Two Million Years” (2016) Nature, doi: <10.1038/nature19798>: Even stabilization of atmospheric concentrations of GHGs at current levels could result in eventual warming of 3°C; Peter U Clark et al, “Consequences of Twenty-First Century Policy for Multi-Millennial Climate and Sea-Level Change” (2016) 6 Nature Climate Change 360 at 361.
\item \textsuperscript{27} UK Science and Technology Committee, supra note 26.
\end{itemize}
Europe and Asia. Two extremely influential national scientific bodies, the United Kingdom’s Royal Society and the US National Academy of Sciences, have also called for national research programs. Moreover, the US Senate Appropriations Committee, in its latest spending bill, has proposed an unspecified level of funding for climate geoengineering research. Also, the Intergovernmental Panel on Climate Change (IPCC), in its most recent assessment report, extensively discussed climate geoengineering options, characterizing them as potential “emergency responses...in the face of potential extreme impacts.” Moreover, the new chair of the IPCC, Hoesung Lee, has advocated research on climate geoengineering options, including governance considerations.

Climate Geoengineering Technologies

Climate geoengineering technologies are usually divided into two broad categories: solar radiation management (SRM) approaches and carbon dioxide removal (CDR) approaches. This section seeks to describe each option in terms of their approaches to addressing climate change.

SRM TECHNOLOGIES

The sun ultimately drives the earth’s climate, including the circulation of the world’s oceans and atmosphere, by emitting energy, largely in the form of short-wave radiation. Approximately two percent of incoming solar radiation reaching the earth (342 W/m²) is absorbed by stratospheric ozone, 17 percent by aerosols and clouds in the troposphere, and 51 percent by the earth’s surface. Thirty percent of solar radiation is subsequently emitted back to space through scattering and reflection by clouds, ice, snow, sand and other reflective surfaces. The remaining 70 percent is absorbed by oceans, the atmosphere and land, and, as they re-emit their absorbed energy, heat is released in the form of long-wave, or infrared, radiation at wavelengths of greater than 1.5 μm. While the atmosphere is transparent to short-wave radiation, it is opaque to long-wave, infrared radiation due to the presence of trace gases found naturally in the atmosphere, including water vapour, carbon dioxide,
methane and nitrous oxide. These so-called “greenhouse gases” (GHGs) radiate back approximately 83 percent of infrared radiation, spreading heat back to land and the oceans, and substantially warming the lower atmosphere. In the absence of this natural greenhouse effect, the average temperature on earth would decline from 57°F to -2.2°F, radically altering life on earth.

For the 10,000 years prior to the mid-nineteenth century, the globe’s temperature was relatively steady at 14°C. For the 10,000 years prior to the mid-nineteenth century, the globe’s temperature was relatively steady at 14°C. However, burgeoning emissions of anthropogenic GHGs have upset the earth’s climate equilibrium, slightly restricting the emission of heat radiation to space. To restore this imbalance, the lower atmosphere has warmed, resulting in the emission of more heat in the form of long-wave radiation. This has resulted in an increase in global temperatures of approximately 1°C since the pre-industrial era. This is termed the “enhanced greenhouse effect.”

SRM methods focus on reducing the amount of solar radiation absorbed by the earth (pegged at approximately 235 W/m² currently) by an amount sufficient to offset the increased trapping of infrared radiation by rising levels of GHGs. Balancing positive global mean radiative forcing of +4 W/m², projected with a doubling of carbon dioxide from pre-industrial levels, would require reducing solar radiative forcing by approximately 1.8 percent. Even a one percent reduction in forcing would have a substantial impact, producing a radiative forcing of −2.35 W/m². Recent studies indicate that deployment of SRM approaches could begin to return temperatures to pre-industrial levels within a few years of deployment and potentially restore temperatures to said conditions by the end of this century.

SRM schemes can be subdivided into two categories: those that seek to reduce the amount of solar radiation reaching the top of the atmosphere and those that seek to reflect solar radiation within the atmosphere (tropospheric-based or in the tropopause and above) or at the surface. The following sections briefly discuss the most frequently discussed SRM options.

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39 Climate Central, “What is the greenhouse effect?” (7 November 2009), online: <www.climatecentral.org/library/faqs/what_is_the_greenhouse_effect>. Radiation from the sun peaks at a wavelength in the range of 0.4–0.7 µ, with small amounts of ultraviolet radiation down to 0.1 µ and small amounts of infrared radiation in the range of 3 µ. The earth, being much cooler, radiates energy at 15°C, with radiation emanation from ranges of 4–100 µ. Martin M Halman & Meyer Steinberg, Greenhouse Gas Carbon Dioxide Mitigation (Boca Raton, FL: Lewis Publishers, 1999) at 1.

40 Hardy, supra note 38 at 8.


43 Carbon dioxide emissions, primarily linked to fossil fuel production, industrial processes and land-use change, have increased over 140 percent from pre-industrial levels. Methane emissions, with anthropogenic sources associated with ruminants, rice agriculture, fossil fuel exploitation, landfills and biomass burning, have increased 254 percent from pre-industrial levels. Nitrous oxide emissions have increased 121 percent from pre-industrial levels, with anthropogenic sources including soils, ocean, biomass burning, fertilizer use and industrial processes. Other anthropogenic GHGs contributing to warming include sulphur hexafluoride, chlorofluorocarbons and halogenated gases, as well as hydrochlorofluorocarbons and hydrofluorocarbons; World Meteorological Organization [WMO] & Global Atmosphere Watch (9 November 2015) 11 WMO Greenhouse Gas Bulletin (November 2015), online: <library.wmo.int/pmb_ged/ggh-bulletin_11_en.pdf>. See also US Environmental Protection Agency, “Global Greenhouse Gas Emissions Data”, online: <www3.epa.gov/climatechange/gghemissions/global.html>.


45 Steve Connor, “Global warming: World already halfway towards threshold that could result in dangerous climate change, say scientists”, Independent (9 November 2015), online: <www.independent.co.uk/environment/climate-change/climate-change-global-average-temperatures-break-through-1c-increase-on-pre-industrial-levels-for-a6727361.html>.


50 The Royal Society, supra note 12 at 23.

51 Ibid.

52 Ibid at 34.


54 Lenton & Vaughan, supra note 35 at 5540.
Sulphur Aerosol Injection

Sulphur aerosol injection (SAI) is considered the most technologically feasible geoengineering option, and thus the most actively investigated currently. SAI seeks to enhance planetary albedo (surface reflectivity of the sun’s radiation) through the injection of a gas such as sulphur dioxide or another gas that will ultimately react chemically in the stratosphere to form sulfate aerosols. Alternatively, this approach may be effectuated through direct injection of sulphuric acid. The high reflectivity of aerosols causes a negative forcing that could ultimately cool the planet. Potential delivery vehicles for stratospheric sulphur dioxide injection include aircraft, artillery shells, stratospheric balloons and hoses suspended from towers.

The genesis of this approach was a suggestion made in 1974 by Russian climatologist Mikhail Budyko that potentially dangerous climate change could be countered by deploying airplanes to burn sulphur in the atmosphere, producing aerosols to reflect sunlight away. A number of recent studies have indicated that SAI could be an effective mechanism to ameliorate projected rises in temperature. A. V. Eliseev and others concluded that the amount of sulphur emissions required to compensate for projected warming by 2050 would be between five and 16 TgS/yr, increasing to between 10 and 30 TgS/yr by the end of the century. Other studies have concluded that considerably smaller injections could achieve the same objective. Proponents have also touted SAI for its allegedly low cost. It has been estimated that injecting enough aerosols into the stratosphere to counter even high-emission scenarios would cost only US$1 billion annually, or less than $0.01 per year to compensate for each ton of carbon dioxide emissions.

There is also empirical evidence to support the potential viability of this approach. Sulfate aerosols are an important component of the troposphere and stratosphere and can substantially reduce the incoming solar radiation reaching the earth’s system during powerful volcanic eruptions. For example, the Mount Pinatubo eruption in 1991 spewed out approximately 20 teragrams of sulfur dioxide into the stratosphere, reflecting enough sunlight back to space to cool the earth by 0.5°C for a year following the eruption.

Marine Cloud Brightening

Low-level marine stratiform clouds cover approximately one-quarter of the oceanic surface and possess albedos of 0.3 to 0.7, thus exerting a substantial cooling effect on the earth’s radiative balance. Cloud albedo enhancement geoengineering schemes contemplate dispersing seawater


56 “Albedo is the fraction of incident sunlight that is reflected.” Albedo is measured on a 0–1 scale. If a surface absorbs all incoming sunlight, its albedo is 0; if it is perfectly reflecting, its albedo is 1. Arctic Coastal Ice Processes, Albedo, online: <www.arcticice.org/albedo.htm>.


droplets approximately one micrometre in size in marine stratiform clouds. These droplets would be sufficiently large to act as cloud condensation nuclei when they rise into the bases of stratiform clouds and shrink through evaporation to about half their original size. Increases in cloud condensation nuclei increase cloud droplet numbers and decrease cloud droplet size. This enhances overall droplet surface area and results in an increase in cloud albedo. Moreover, it can extend the longevity of clouds, increasing the time-mean albedo of a region.

Studies indicate that a 50 percent to 100 percent increase in droplet concentration of all marine stratiform clouds by mechanical generation of sea salt spray could increase top-of-cloud albedo by 0.02 (approximately 10 percent), which could offset warming associated with a doubling of atmospheric carbon dioxide. However, there are substantial uncertainties associated with this approach, including whether increasing cloud condensation nuclei might ultimate result in evaporation that disrupts cloud albedo. Moreover, the requisite top-of-cloud albedo to offset the warming associated with a doubling of carbon dioxide levels from pre-industrial levels would be markedly greater than estimated in previous studies.

Stephen Salter and others have proposed the development of a fleet of approximately 1,500 remotely controlled spray vessels, drawing upon the motion from the vessels to drive underwater propellers to generate the energy for spray production. As is the case with sulphur dioxide injection schemes, the cost of this approach could be extremely low, perhaps no more than $9 billion.

### Space-based Systems

Space-based methods seek to reduce the amount of solar radiation reaching the earth by positioning sunshields in space to reflect or deflect radiation. As is true with several other SRM options, it may be possible to reduce solar radiation inflows by 1.8 percent, potentially offsetting greenhouse effects associated with a doubling of atmospheric carbon dioxide concentrations. Proposed options include placing reflectors in near-earth orbits, including the placement of 55,000 mirrors in random orbits or the creation of a ring of dust particles guided by satellites at altitudes of approximately 1,200 to 2,400 miles. An alternative approach could be to establish a “cloud of spacecraft” with reflectors in a stationary orbit near the Inner Lagrange point (L1), a gravitationally stable point between earth and the sun. Proponents argue that this approach would ensure the stability of sunshades, whereas shields positioned in near-orbit could be pushed out of orbit by sunlight.

Deployment of space-based systems could prove to be challenging, however. Some configurations of sunshades could prove to be unstable and, thus, ultimately sail out of orbit. Low earth orbit systems could also face tracking problems, posing the threat that mirrors could...
collide. The cost of deployment would also be extremely high, pegged at approximately $5 trillion by one major proponent, with some commentators projecting the cost to be potentially much higher. Given the existence of cheaper and less logistically challenging SRM options, “sunshade” approaches are not likely to be launched any time soon.

**CDR APPROACHES**

CDR options seek to remove and sequester carbon dioxide from the atmosphere, either by enhancing natural biological sinks for carbon or by deploying chemical engineering to remove carbon dioxide from the atmosphere. This, in turn, can increase the amount of long-wave radiation emitted by the earth back to space, reducing radiative forcing and thus exerting a cooling effect.

In contrast to SRM options, which can begin to affect temperatures very rapidly, CDR approaches would likely have to be deployed on a large scale for at least a century to substantially reduce atmospheric concentrations of carbon dioxide. However, also in contrast to SRM options, CDR technologies address the proximal cause of warming and could restore carbon dioxide to pre-industrial levels within a few centuries. In the following sections, the most frequently discussed CDR options will be discussed.

**Ocean Iron Fertilization**

In a process known as “the biological pump,” the production of organic matter by phytoplankton in the world’s oceans results in the absorption of carbon dioxide from the atmosphere to facilitate photosynthesis, thus lowering concentrations. While phytoplankton account for less than one percent of photosynthetic biomass, they are responsible for approximately half of the carbon fixation on earth. A proportion of particulate organic carbon from phytoplankton sinks into the deeper ocean (below 200 m) before it decays, and can remain at these depths, thus sequestering carbon dioxide from the atmosphere, for hundreds of years.

Phytoplankton production, in turn, is dependent on a variety of nutrients, including macronutrients, such as nitrogen and phosphate, and micronutrients, such as iron and zinc. Proponents of an option known as ocean iron fertilization argue that phytoplankton production is limited due to low concentrations of iron in the southern ocean, subarctic Pacific and eastern equatorial Pacific waters. They argue that adding iron artificially in these regions could stimulate phytoplankton production, thus enhancing carbon dioxide uptake.

Several studies in the past few decades have indicated that ocean iron fertilization could reduce atmospheric carbon dioxide levels substantially, perhaps by 10 percent or...
more. However, a number of more recent studies, largely reflecting field research on ocean iron fertilization, have questioned these findings. The IPCC, in its most recent assessment report, has concluded that the drawdown of atmospheric carbon dioxide with ocean iron fertilization could be as low as 15 to 30 parts per million, even under idealized conditions. Moreover, the Secretariat of the Convention on Biological Diversity, in its synthesis report on geoinfrastructure, concluded that ocean iron fertilization could only exert a “minor impact” on atmospheric concentrations of carbon dioxide.

Bioenergy with Carbon Capture and Storage

Bioenergy with carbon capture and storage (BECCS) is a process by which biomass is converted to heat, electricity or liquid or gas fuels, coupled with carbon capture and sequestration (CCS). Bioenergy feedstocks include the following:

- energy derived from woody biomass harvested from forests, including fuel wood, charcoal and residues;
- energy crops, such as jatropha and palm;
- food crops, including corn, sweet sorghum and annual crops, such as switchgrass; and
- agro-residues (animal manure and crop residues), agro-industrial and municipal solid wastes and other biological resources.

In the context of power production facilities, the CCS process involves capturing carbon dioxide from flue gases in the post-combustion phase or modifying the combustion process to generate pure or high-concentration streams of carbon dioxide. BECCS technologies could capture 90 percent or more of the carbon dioxide released through biomass production.

After capture, carbon dioxide is compressed and transported to a site for storage, either underground or in the oceans. There are also proposals for using carbon dioxide for other purposes, such as enhanced oil recovery and biochemical conversion into biofuels or for energy storage technologies.

BECCS is one of a group of carbon dioxide removal options characterized as “negative emissions technologies” (NETs) because these approaches are capable of removing GHGs from the atmosphere, capturing carbon dioxide at the source or engineering enhancement of natural carbon sinks. BECCS effectuates this by the absorption of carbon dioxide through the growth cycle of biomass feedstocks and the capture of the carbon dioxide produced during the combustion of biomass energy. The vast majority of

mitigation scenarios developed in integrated assessment models, under which temperatures are kept to 2°C or below, contemplate extensive deployment of NETs during the course of this century, with BECCS cited as the primary NETs option. However, the actual potential of BECCS to sequester carbon is highly uncertain at this incipient stage of development. One recent study projected potential sequestration of 1.5 GtCO₂/yr by 2050 and 5 to 16 GtCO₂/yr by 2100, while another pegs the potential range at between 1.8 and 17.4 GtC/yr. By means of comparison, global carbon dioxide emissions in 2015 were estimated to be 35.7 GtC.

Direct Air Capture

Direct air capture (DAC) is a process for extracting carbon dioxide from ambient air in a closed-loop industrial process. The most widely discussed method involves drawing air through towers and bringing it into contact with a chemical solution that naturally absorbs carbon dioxide, such as sodium hydroxide, in a device called a contactor. These machines could be capable of capturing 1,000 times more carbon dioxide than could a tree of comparable size.

Once carbon dioxide-capturing sorbents become saturated, a regeneration process is used to release the carbon dioxide for pipeline compression and storage or re-use in other processes. Captured carbon dioxide could be stored using the methods described above in terms of BECCS or for alternative purposes. One clear benefit of DAC systems is that they can facilitate uptake of carbon dioxide emissions from small and hard-to-control distributed sources, such as the transportation sector, which constitute more than half of total emissions. As is the case with BECCS, DAC constitutes a negative emissions technology. One recent study of DAC potential in the United States alone estimated that it might be possible to sequester approximately 13 GtCO₂/yr, with cumulative removal of approximately 1,100 Gt up to 2100, while another study estimated sequestration potential of between 3.7 and 10 GtCO₂/yr by 2100.

While there are efforts currently to develop pilot demonstration projects, an imposing barrier to large-scale deployment of DAC may be its potential costs, with some estimates ranging from $600 to thousands of dollars per ton of captured carbon dioxide. However, other researchers...
have contended that the costs could be much lower. Other challenges would include finding suitable sites for carbon dioxide sequestration, as well as safety, public perception and sequestration reliability questions.

**Potential Risks Associated with Climate Geoengineering**

**SRM OPTIONS**

**Potential Precipitation Impacts**

SAI geoengineering could adversely impact the globe’s hydrological cycle. SAI could abate increases in surface temperatures by reducing incoming solar radiation. However, continued simultaneous absorption of long-wave radiation by rising levels of atmospheric carbon dioxide could increase the vertical stability of atmosphere. This could, in turn, suppress convective activities and, most importantly, precipitation. Additionally, infrared absorption by the introduction of sulphur aerosols into the stratosphere could decrease the downward emission of infrared radiation into the troposphere, further reducing precipitation.

While the deployment of SAI geoengineering could result in a decline in mean global precipitation, its impacts could be far more severe in the global south. H. Schmidt and others projected that deployment could reduce precipitation by 20 percent in the southern branch of the inter-tropic convergence zone, with U. Niemeier reaching similar findings. Reductions of this magnitude could modify the Asian and African monsoons, “impacting the food supply to billions of people” and visiting “humanitarian disasters” upon such regions. The South Asian summer monsoon provides up to 80 percent of annual mean precipitation in India, sustaining the country’s agriculture, health and water needs. In Africa, production of important crops such as maize are critically linked to the timing and duration of precipitation. Recent research indicates that deployment of SAI in the northern hemisphere could trigger droughts in the Sahel, potentially reducing net primary productivity by 60 to 100 percent. There is also empirical support for this proposition. As indicated above, when Mount Pinatubo erupted in 1991, it released approximately 20 teragrams into the stratosphere. This is the mid-range estimate of the amount of sulphur dioxide that might have to be injected into the stratosphere by the end of the century to compensate for twenty-first century warming. In the year following the eruption, the earth experienced the least amount of rainfall on record, more than 50 percent lower than in any previous year, as well as a record decrease in runoff and discharge into the ocean.

However, one must be cautious about potential precipitation impacts of SRM options, and substantial

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126 Climate Intervention: Reflecting Sunlight to Cool Earth, supra note 30 at 75.


132 The Royal Society, supra note 12 at 31.


137 Kravitz, supra note 65.

138 Eliseev, Mokhov & Karpenko, supra note 61 at 390.


additional research would clearly be needed if such options were to be considered.141 As Simon Tilmes and others observe, “different models and scenarios do not always agree in the sign of the change of monsoonal precipitation in response to geoengineering.”142 Moreover, some researchers contend that temperature reductions associated with SRM deployment would also decrease evaporation, increasing soil moisture and potentially offsetting any possible loss in food production.143

Marine cloud brightening geoengineering options also pose dangers in this context. One recent study indicated that deployment could reduce precipitation by 50 percent in some areas of South America, with a corresponding decline in net primary productivity by as much as 50 to 100 percent.144 The impact of space-based systems on precipitation remains unclear,145 but several researchers have expressed fear about potential adverse impacts on regional precipitation, especially in the tropics.146

Potential Impacts on the Ozone Layer

Sunlight-related skin cancer is responsible for approximately 60,000 human deaths annually, as well as hundreds of thousands of new cases and billions of dollars in direct economic losses.147 The diminution of the ozone layer over the past few decades, which is primarily attributable to anthropogenic ozone-depleting substances, is a major contributor to these impacts.148 Fortunately, the establishment of the Montreal Protocol, with its scheduled phaseout of most ozone-depleting substances, has been projected to reduce the number of skin cancer cases by 14 percent annually by 2030, translating into two million cases. Moreover, these numbers are anticipated to “grow dramatically” thereafter.149

Deployment of SAI geoengineering options, however, could radically change this equation. Injection of sulphur dioxide particles into the stratosphere would substantially increase the available surface areas for heterogeneous reactions in which inactive forms of chlorine and bromine could be converted to forms that could facilitate catalytic destruction of ozone.150 Thus, while current international policies could facilitate a return of stratospheric ozone levels to their original states by 2050,151 large-scale deployment of SAI geoengineering options could delay recovery of the ozone layer for 30 to 70 years or more.152 Moreover, the projected loss of ozone would be “remarkable,” perhaps reaching levels higher than the peak of depletion by ozone-depleting substances in the last century.153 In some winters, the loss of ozone would be comparable to the total amount of ozone available in the lower portions of the stratosphere.
above the Arctic, with drastic declines over the Antarctic as well.\textsuperscript{154}

### The Threat of a Termination Effect

The “termination effect” refers to the potential for a huge multi-decadal pulse of warming, should the use of a deployed SRM scheme be terminated abruptly due to technological failure, a pandemic, war or a decision by future policy makers that its negative impacts compelled them to do so.\textsuperscript{155} This would be a consequence of the buildup of carbon dioxide that had accrued in the atmosphere in the interim, with its suppressed warming effect, as well as the temporary suppression of climate-carbon feedbacks.\textsuperscript{156}

The ramifications of the termination effect could be “catastrophic.”\textsuperscript{157} As one study recently concluded, “[S]hould the engineered system later fail for technical or policy reasons, the downside is dramatic... The climate suppression has only been temporary, and the now CO\textsubscript{2}-loaded atmosphere quickly bites back, leading to severe and rapid climate change with rates up to 20 times the current rate of warming of approximately 0.2°C per decade.”\textsuperscript{158}

As a consequence, temperatures could increase 6°C to 10°C in the winter in the Arctic region within 30 years of termination of the use of SRM technology, with northern land masses seeing increases of 6°C in the summer.\textsuperscript{159}

Moreover, temperatures could jump 7°C in the tropics in 30 years.\textsuperscript{160} Projected temperature increases after termination would occur more rapidly than during one of the most extreme and abrupt global warming events in history, the Paleocene-Eocene Thermal Maximum.\textsuperscript{161} It is beyond contention that climatic changes of this magnitude “could trigger unimaginable ecological effects.”\textsuperscript{162} To put this rate of temperature increase in perspective, even a warming rate of greater than 0.1°C per decade could threaten most major ecosystems and decrease their ability to adapt.\textsuperscript{163} Should temperatures increase at a rate of 0.3°C per decade, only 30 percent of all impacted ecosystems and only 17 percent of all impacted forests would be able to adapt.\textsuperscript{164} Moreover, temperature increases of this magnitude and rapidity would imperil many human institutions.\textsuperscript{165}

It is also likely that the termination effect would have disproportionate impacts on some of the world’s poorest and most vulnerable peoples, as the greatest acceleration of warming over land would be projected to occur in lower latitudes.\textsuperscript{166} Moreover, net primary productivity could decline in low latitude regions.\textsuperscript{167}

### CDR OPTIONS: POTENTIAL NEGATIVE IMPACTS

Ocean iron fertilization could pose several risks to ecosystems and humans who rely on ocean resources. Assuming that fertilization spurs the proliferation of phytoplankton, there is a real danger that it could result in shifts in community composition that could threaten

\textsuperscript{154} Tilmes, Müller & Salawitch, \textit{supra} note 152 at 1203. Stratospheric ozone depletion increased in the Arctic after the eruption of Mt. Pinatubo released 20 Mt. of SO\textsubscript{2} into the stratosphere in 1991; Tilmes et al, \textit{supra} note 142 at 11,037. It was estimated that the global column ozone loss after Mt. Pinatubo was 2.5 percent, while the loss after the eruption of El Chichón in 1982 was approximately 16 percent; Paul Crutzen, “Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma” (2006) 77 Climatic Change 211 at 215.


\textsuperscript{161} \textit{Ibid}.


\textsuperscript{163} It seems likely that two decades of very high rates of warming would be sufficient to severely stress the adaptive capacity of many species and ecosystems, especially if preceded by some period of engineered climate stability.”


\textsuperscript{167} \textit{Ibid}.
the integrity of ocean ecosystems. For example, during one study, the CROZet Natural Iron Bloom and EXport Experiment (CROZEX), iron fertilization resulted in the increased abundance, diameter, and biomass of *Phaeocystis antarctica*, a colonizing species that proved unpalatable to mesozooplankton in the region. Should this occur on a large scale in fertilized oceans, it could result in so-called “regime shifts,” with associated large-scale changes in regional biogeochemistry and the structure of the food web. This could include impacts on large predators, including copepods, krill, salps, jellyfish and other fish, with “potentially devastating” consequences. Of course, it is also possible that species higher on the food chain could ultimately benefit from fertilization, but this remains far from certain.

Phytoplankton blooms can also block sunlight in deeper waters and overload bacterial decomposers that take up oxygen. Thus, ocean iron fertilization strategies that stimulate phytoplankton production might produce hypoxic (low-oxygen) or anoxic (oxygen-deprived) ocean environments. Hypoxic or anoxic environments can result in massive fish kills, as well as increased mortality rates for critical prey species, such as krill, which serve as the base of the southern ocean food chain. Ocean iron fertilization could also generate large diatom blooms that could produce a highly potent neurotoxin, domoic acid, as well as toxic algal blooms in coastal waters that could threaten food webs. Also, it could remove nutrients and stunt phytoplankton growth in other areas where this is naturally occurring, as recent model simulations from the tropical eastern Pacific suggest. Finally, enhancement of oceanic uptake of carbon dioxide could substantially increase ocean acidification, including accelerating the threshold for serious impacts in the southern ocean by a few decades. Ocean acidification could imperil many ocean species, including calcifying species and important commercial fish species.

Large-scale deployment of BECCS could pose both socioeconomic and environmental risks. One striking feature of BECCS is the potential amount of land that might be required to be diverted from other uses, including food production and livelihood-related activities, to provide bioenergy feedstocks. A recent study projected that delivery of three gigatons of carbon dioxide equivalent negative emissions annually would require a land area of approximately 380 to 700 million hectares in 2100, translating into seven to 25 percent of agricultural land and 25 to 46 percent of arable and permanent crop area. The range of land demands would be two to four times larger than land areas that have been classified as abandoned or marginal. This relatively modest level of emissions removal would be equivalent to a startling 21 percent of total current human appropriate net primary productivity. While it might be possible to reduce these impacts by emphasizing the use of agricultural residue and waste feedstocks, this option could prove to be extremely
limited. Reliance on so-called “second generation” lignocellulosic feedstocks that are produced from the woody part of plants, such as wheat straw and corn husks, or algal biofuels could also substantially reduce pressure on agricultural and forest lands. However, there are currently serious technical and economic constraints that severely restrict production.

Demands of this magnitude on land could substantially raise food prices on basic commodities. This could imperil food security for many of the world’s most vulnerable, with many families in developing countries already expending 70 to 80 percent of their income on food. There is empirical evidence to support this proposition in the context of efforts in the past decade to increase biofuel expansion. Biofuel expansion, in many cases at the expense of food production, was one of the major factors precipitating substantial spikes in food prices in 2007-2008 and 2012. Food price increases and the reduction of food production imperiled the food security of many in Africa and in other parts of the developing world. Increases in food prices in 2007 led to food riots in a number of countries and elevated the number of people living in hunger to an historical high of over one billion. According to a 2008 report by Oxfam, the “scramble to supply” biofuels such as palm oil, which was partly driven by EU biofuel targets, exacerbated the food price crises, brought “30 million people into poverty” and put 60 million indigenous people at risk. While it is difficult to estimate the impact of large-scale deployment of BECCS on food prices, even the far more modest goal of scaling up biofuels production could result in price increases of 15 to 40 percent.

Efforts to develop feedstock for bioenergy can also result in the displacement of the poor from land, which can undermine food security, livelihoods, political power and social identity. A recent report listed more than 293 reported “land grabs” for the purposes of biofuel plantation expansion, encompassing more than 17 million hectares of land. Moreover, there is ample historic evidence of land seizures from vulnerable populations for other economic enterprises, including mineral extraction and industrial projects. While supporters of BECCS contend that bioenergy expansion can be effected primarily through “marginal,” “degraded” or “abandoned” land, most often found in developing countries, the reality is that hundreds of millions may rely on these lands for income and

184 Caldecott, Lomax & Workman, supra note 106 at 16.


sustenance. For example, substantial portions of grazing lands are barren during the dry season in developing countries and are, thus, classified as “degraded.” Yet, these lands are often productive during the rainy season and are relied upon for food and income by poor families.

Finally, incentives for feedstock production may result in farmers converting substantial swaths of land from food crop production, reducing food supply for local populations. For example, in one region of Brazil, conversion of land from cassava and rice production to oilseed for biofuel production undermined food security. A recent study indicated that more than half of the world’s bioenergy potential is centred in two regions with very large poor and food-vulnerable populations: Sub-Saharan Africa and Latin America and the Caribbean.

BECCS would also have “a very large water footprint” when implemented at a scale of between 1.1 and 3.3 GtCO₂ equivalent per year. By 2100, BECCS feedstock production at scale could require approximately 10 percent of the current evapotranspiration from all global cropland areas. Markus Bonsch and others project that BECCS of the current evapotranspiration from all global cropland production at scale could require approximately 10 percent GtCO₂ equivalent per year. By 2100, BECCS feedstock operations would also be water-intensive, potentially requiring four percent of total current evapotranspiration used for crop cultivation.

Finally, BECCS could “vastly accelerate the loss of primary forest and natural grassland.” This could result in habitat loss for many species and, ultimately, “massive” changes in species richness and abundance. Moreover, the water demands associated with BECCS could have “substantial adverse impacts on freshwater ecosystems, particularly in South Asia.” Indeed, Phil Williamson concluded that large-scale deployment of BECCS could result in a greater diminution of terrestrial species than temperature increases of 2.8°C above pre-industrial levels.

THE APPLICATION OF HUMAN RIGHTS TO CLIMATE GEOENGINEERING

Overview of the International Human Rights Framework

“Human rights are universal legal guarantees protecting individuals and groups against actions and omissions that interfere with fundamental freedoms, entitlements

Rachel Smolker & Almuth Ernsting, “BECCS (Bioenergy with Carbon Capture and Storage): Climate Saviour or Dangerous Hype?” (October 2012) at 8, online: Biofuelwatch <www.biofuelwatch.org.uk/2012/beccs_report/>; Secretariat of the Convention on Biological Diversity, supra note 185 at 32.


Smith et al, supra note 181 at 47.

Bonsch et al, supra note 181 at 12.

and human dignity.”214 As such, they establish minimum standards for individuals and groups that cannot be contravened in the pursuit of aggregate societal benefits.215 Most fundamentally, human rights protections seek to ensure that laws and political and social structures are grounded in moral reasons and discourse and are justifiable within a framework of appropriate legal and political structures.216 Human rights provide a critical link between the protection of a vital interest and the imposition of a duty on others to protect and promote the interest.217


220 ICESCR, 16 December 1966, 993 UNTS 3, 6 ILM 360 (entered into force 3 January 1976), online: <www.ohchr.org/EN/ProfessionalInterest/Pages/CESCR.aspx>.


and the Arab Charter on Human Rights. States are also legally bound by human rights principles recognized by customary international law. For example, and particularly relevant to the question of geoengineering, the right to self-determination under international law is particularly relevant to the question of geoengineering, the right to self-determination under international law is recognized as “both individual from and a prerequisite for the realization of all other human rights.”

Non-legally binding instruments include the 1948 Universal Declaration of Human Rights (UDHR), the 1986 Declaration on the Right to Development, the 1993 Vienna Declaration and Programme of Action, the 1995 Beijing Declaration and Platform for Action, the 2007 Declaration on the Rights of Indigenous Peoples and the 2012 Association of Southeast Asian Nations (ASEAN) Human Rights Declaration. It should be recognized that the UDHR as a whole, or at least some portions, has been widely recognized as customary international law.

The UDHR, ICESCR and ICCPR form the so-called “International Bill of Rights.” Virtually every state belongs to at least one of the two major human rights treaties, and more than 160 states belong to both the ICCPR and ICESCR. All major emitters of GHG emissions are parties to both the ICESCR and ICCPR, with the exception of the United States, which has signed but not ratified the ICESCR, and China, which has signed but not ratified the ICCPR.

Parties to human rights treaties are not only required to respect human rights, that is, to refrain from taking actions that might imperil the exercise of human rights, but they are also obligated to protect and fulfill these obligations. The obligation to protect imposes a duty on states to take affirmative measures to deter, prevent, investigate and punish violations of human rights by private actors. The obligation to fulfill imposes a duty on states to take positive actions to progressively facilitate the enjoyment of human rights. This may include legal, judicial, policy and budgetary measures by state organs.

In 1997, the UN Secretary-General launched an initiative to “mainstream” human rights as a cross-cutting concern of United Nations system activities. Additional impetus for strengthening the application of human rights at the international and national level in recent years included


244 Ibid.

245 Elisabeth Caesens & Maritere Padilla Rodriguez, Climate Change and the Right to Food (Berlin: Heinrich Böll Stiftung, 2009) at 43, online: <https://www.boell.de/sites/default/files/Series_Ecology_Volume_8_Climate_Change_and_the_Right_to_Food_0.pdf>.


the Millennium Declaration of 2000 and the Secretary-General’s 2002 reform program, which directed the OHCHR to work with UN partners to strengthen human rights at the country level. These efforts helped to lay the foundation for the development of international efforts to protect human rights potentially impacted by climate change, as well as response measures. In the next section, the potential threats that some climate geoengineering options might pose for the human rights protected in these agreements are outlined.

Potential Threats to Human Rights from Deployment of Geoengineering Options

THE RIGHT TO FOOD

The right to adequate food is established by a number of human rights instruments at the international and regional levels, including the ICESCR, which seeks to protect “the fundamental right of everyone to be free from hunger.” The OHCHR has commented that states must take necessary actions to ensure freedom from hunger and access to adequate food, “even in times of natural or other disasters.” The ICESCR Committee General Comment No. 12 states that “accessibility encompasses both economic and physical accessibility.” Therefore, the comment continues, vulnerable groups such as displaced peoples and indigenous populations “may need attention through special [programs].” As indicated earlier, the deployment of either SAI or marine cloud brightening SRM approaches could adversely impact regional precipitation patterns, potentially threatening the food security of billions. This could constitute a violation of the right to food, in terms of both potential deployers of such technologies and potentially affected states, whose governments might be obligated to take additional measures to protect the most vulnerable. Similarly, as discussed earlier, deployment of BECCS could raise food prices and/or displace agricultural production in ways that could also imperil food security and violate the right to food. Finally, should the termination effect described earlier manifest itself, the attendant rapid spikes in temperature might undermine food production in many parts of the world, including vulnerable portions of the South.

THE RIGHT TO HEALTH

The right to health is included in a large number of human rights treaties and soft-law instruments as well as at least 115 national constitutions. It is most comprehensively established in the ICESCR as “the right of everyone to the enjoyment of the highest attainable standard of physical and mental health.”

The ICESCR Committee interprets the right to health in General Comment No. 14 to include “a wide range of socio-economic factors that promote conditions in which people can lead a healthy life, and extends to the underlying determinants of health, such as...a healthy environment.” General Comment No. 14 further states that the right to health includes “a right to the enjoyment of a variety of facilities, goods, services and conditions necessary for the realization of the highest attainable


255 Ibid.

256 See e.g. UDHR, supra note 235, art 25 (part of the right to an adequate standard of living); CRC, supra note 224; International Convention on the Rights of Persons with Disabilities, supra note 229, art 25(r); Convention on the Elimination of All Forms of Discrimination against Women, supra note 222, art 12; African Charter on Human and Peoples’ Rights, supra note 231 (implicit in arts 4, 16, and 22).

257 Royal Society, supra note 12.


259 UDHR, supra note 235, art 25; Convention on the Elimination of All Forms of Racial Discrimination, supra note 221, art 5(e)(v); CRC, supra note 224, art 24; Convention on the Elimination of All Forms of Discrimination against Women, supra note 222, arts 11(1)(5), 12, 14(2)(b); International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families, supra note 225, arts 28, 43(e), 45(c); African Charter on Human and Peoples’ Rights, supra note 231, art 10; Constitution of the World Health Organization (WHO), 22 July 1946, 14 UNTS 185, Preamble.


261 ICESCR, supra note 220, art 12.


250 United Nations Millennium Declaration, GA Res 2, UNGAOR, 55th Sess, UN Doc A/Res/55/2 (2000), online: <un.org/millennium/declaration/ares552e.pdf>. The declaration’s pertinent provisions on human rights include a call for respect for “all internationally recognized human rights” (Sec V, para 24) and efforts to strengthen the capacity of states to protect human rights (Sec V, para 25).


252 See e.g. UDHR, supra note 235, art 25 (part of the right to an adequate standard of living); CRC, supra note 224; International Convention on the Rights of Persons with Disabilities, supra note 229, art 25(r); Convention on the Elimination of All Forms of Discrimination against Women, supra note 222, art 12; African Charter on Human and Peoples’ Rights, supra note 231 (implicit in arts 4, 16, and 22).

253 ICESCR supra note 220, art 11(2).

254 OHCHR, supra note 6 at 9.


256 Ibid.
standard of health.” 263 Additionally, states are required to take measures to ensure that private actors within their control do not violate the human right to health. 264

Several climate geoengineering options could potentially affect the right to health. As indicated earlier, sulphur aerosol injection might delay replenishment of the ozone for decades, imperilling the health of millions. Moreover, to the extent that food production might be adversely impacted by deployment of SRM or CDR approaches, they would undermine one of the “underlying determinants of health.” 265

THE RIGHT TO WATER

A number of human rights instruments recognize the right to water. 266 The ICESCR Committee in General Comment No. 1 provides that the state’s duty to respect the right to water requires refraining from interfering with the enjoyment of that right and protecting the right by adopting measures to restrain third parties from interfering with the right. 267

In 2010, the UN General Assembly also officially recognized the “right to water and sanitation.” 268 The UNHRC subsequently adopted HRC Resolution 15/9, which “affirms that the rights to water and sanitation are part of existing international law and confirms that these rights are legally binding” upon states parties to the ICESCR. 269 A number of regional courts have found that the right to safe drinking water and sanitation derives from other human rights, such as the rights to life, health and adequate housing, 270 even though the right is not explicitly mentioned in regional human rights instruments. 271

The potential alteration of precipitation patterns associated with SRM approaches 272 could imperil the right to water for huge numbers of people. Marine cloud brightening involving the potential deposition of sea water could also reduce freshwater availability for islands where water resources are already severely constrained. 273 Moreover, the massive demands on water that some CDR approaches, such as BECCS, would entail, could similarly impact this right.

THE RIGHT TO LIFE

The UDHR explicitly recognizes the right to life, 274 as does article 6(1) of the ICCPR, which guarantees every human the “inherent right to life.” 275 Many other international and regional human rights instruments also recognize the right to life. 276 Moreover, a large number of states also recognize the right to life through constitutional provisions or legislatively. 277

Because the right to life is elemental to the protection of all others, no derogation is permitted by governments,
even in times of purported public emergency. The right has also been construed expansively on other axes. It requires states to “adopt positive measures” to protect the right. It may also require application of a precautionary approach, meaning that governments must seek to prevent foreseeable harms or risks. Moreover, the right to life has been construed to transcend mere protection from arbitrary violence, and it encompasses threats to the quality of life, including those related to environmental factors, human health and access to food and water.

Many climate geoengineering options could threaten the right to life. These include potential impacts that might induce drought conditions, deplete the ozone layer, reduce food security or precipitate large and rapid pulses of warming.

**Potential Threats to Biodiversity and Human Rights**

As indicated above, BECCS could result in substantial diminution of biodiversity. Other geoengineering approaches might also threaten species at both the local and global level. For example, many species might be unable to adapt, or migrate quickly enough, should the termination effect occur in the context of SRM options. SRM approaches might also alter global ocean circulation patterns through changing light availability, which is partially determined by incoming solar radiation. Such changes in circulation and ocean nutrient upwelling could have potential impacts on biodiversity through the entire marine ecosystem.

Loss of biological diversity could also undermine the right to health by leading to an increase in the transmission of infectious diseases, such as hantavirus, Lyme disease and schistosomiasis. Moreover, products and services derived from biodiversity are a critical economic resource for many of the world’s poor, including indigenous peoples. Diminution of biodiversity through deployment of geoengineering options could undermine the right to livelihood, which, in turn, is intimately linked to the human right to life and an adequate standard of living for health and well-being of individuals and families.

Loss of biodiversity could also undermine the right of indigenous peoples to access such resources.

**OPERATIONALIZING HUMAN RIGHTS PROTECTIONS UNDER THE PARIS AGREEMENT IN THE CONTEXT OF CLIMATE GEOENGINEERING**

**Overview/Application of the HRBA**

As indicated at the outset, the Paris Agreement calls on its parties to take human rights into account “when taking action to address climate change.” This section of the report will suggest how this provision might be operationalized by the parties in the context of climate geoengineering.

The suggested framework outlined below for doing so is denominated a “human rights-based approach.” As Margaux J. Hall explains, “[A] human rights-based approach is a conceptual framework for decision making...”
that is normatively grounded in international human rights principles. The approach focuses not only on substantive outcomes and promoting and protecting human rights; it also closely investigates the processes that underlie human rights-related decision making.293

The hallmark of the HRBA is a focus “on the relationship between the rights-holder and the duty-bearer and revealing gaps in legislation, institutions, policy and the possibility of the most vulnerable to influence decisions that have impact on their lives.”294 An HRBA establishes a normative framework “for addressing systematic and structural injustices, social exclusions and human rights repressions.” 295

The emphasis of the HRBA on effective processes to address and integrate human rights at all governmental scales is particularly important, since legal institutions are only able to respond to a small percentage of rights violations.297 The HRBA has been embraced by international, national and subnational governmental and non-governmental organizations in a wide array of contexts, including, health, development and environmental protection.298 The parties to the Paris Agreement can facilitate this process under any circumstances where a party, or group of parties, would seek to implement geoengineering responses to climate change.

Drawing upon guidelines developed by human rights and development institutions,299 an HRBA to climate geoengineering research and potential deployment should include the following elements: identification of the human rights claims of rights-holders and corresponding human rights obligations of duty-bearers; assessment of the capacity of rights-holders to exercise their rights and duty-bearers to fulfill their respective obligations, as well as strategies to bolster capacities; establishment of a program to monitor and evaluate both outcomes and processes, guided by human rights standards and principles; and collaboration to ensure that programs are informed by recommendations from international human rights bodies and mechanisms.

IDENTIFICATION OF HUMAN RIGHTS CLAIMS AND OBLIGATIONS

This paper has generally outlined some of the potential human rights that might be affected by research and potential deployment of climate geoengineering technologies and some of the groups that might be affected. An HRBA would demand, and seek to facilitate, a much more granular inquiry by seeking to identify the specific potential impacts of discrete climate geoengineering technologies and associated potential human rights considerations, as well as the specific groups likely to be impacted.

A salutary method to effectuate this goal would be to mandate conducting a human rights impact assessment (HRIA) in any case where a geoengineering research program or deployment might have serious impacts on human rights. HRIs are assessment protocols that assess the consistency of policies, legislation, projects and programs with human rights.300 The HRIA is a particularly appropriate instrument in the context of emerging high-risk technologies such as geoengineering in that its focus is not on past violations but rather on developing tools to avoid violations of rights in the future.301

HRIs could be conducted in conjunction with environmental impact assessments (EIAs). EIAs almost assuredly would be legally mandated at the national and/ or international level for any geoengineering research

293 Margaux J Hall, “Advancing Climate Justice and the Right to Health Through Procedural Rights” (June 2014) 16(1) Health & Hum Rts 8 at 15. See also Ken Conca, An Unfinished Foundation (New York, NY: Oxford University Press, 2015) at 147. HRBAs’ value “does not come from formal affirmations of such synergies, or even from the articulation of obligations facing states. It comes, ultimately, from the empowerment of people.”


299 International Human Rights Law Clinic, supra note 11 at 15; UN High Commissioner for Refugees, Climate Change, Natural Disasters and Human Displacement: A UNHCR Perspective (14 August 2009) at 11, online: <www.unhcr.org/4901e81a4.pdf>.

300 The World Bank & Nordic Trust Fund, supra note 246 at 1.

301 Ibíd.
program or deployment that might have substantial environmental impacts. There are four elements that a geoengineering HRIA should include. Each is discussed in turn.

First, a geoengineering HRIA should include a scoping process that would identify rights-holders and duty-bearers and would develop relevant indicators to use in the process to help assess potential impacts and their relevance to the human rights interests of rights-holders.

In identifying rights-holders, an HRBA focuses on protection of the rights of excluded and marginalized populations, including those whose rights are most likely to be threatened. An HRBA also emphasizes that rights-holders are not protected merely by the “benevolence” of states but rather that governments are required to “work consistently towards ending denials or violations of human rights.” The HRIA process should reflect these principles also.

Initial development of human rights indicators began in the 1990s as a means of assessing compliance with human rights treaties vis-à-vis projects or programs. Indicators fall into three broad categories: structural, which seek to assess state intent to comply with human rights law; process, which measure state efforts to implement human rights, as well as steps taken to ensure protection of rights, including transparency, accountability of institutions and existence of consultations with stakeholders; and outcome, which measure state human rights performance. Indicators focus on capturing quantitative information on human rights; however, qualitative statements can complement data by putting information into perspective. For example, a pertinent HRIA indicator in the context of BECCS could be the amount of croplands that might be diverted in a state for bioenergy feedstocks and the potential impacts on local food production. This quantitative data might be supplemented by testimony from indigenous tribes and their experience in protecting their interests in a region where such projects are being developed.

Second, a geoengineering HRIA should include an evidence-gathering process to help assess the potential impacts of geoengineering research or deployment.

One critical requirement of the HRBA process would be greatly enhanced scientific understanding of the impacts of specific geoengineering options, including regional impacts that might adversely impact specific potential rights-holders. For example, in the context of SRM approaches, general circulation models (GCMs) would play a critical role in preliminary assessments. However, GCMs currently do not perform well in modelling regional impacts of SRM geoengineering options, especially in terms of the critical consideration of precipitation. An HRBA would exert pressure on researchers and policy makers to conduct such research to identify potential “winners” and “losers.” This might include enhanced funding of the Geoengineering Model Intercomparison Project (GeoMIP), which seeks to establish a consensus among climate models in terms of geoengineering technologies.


307 de Beco, supra note 305 at 383.

308 General circulation models seek to numerically simulate the response of the global climate system to perturbations, such as GHG emissions, or in the case of solar radiation management, interventions such as SAI, by representing pertinent physical processes in the atmosphere, oceans, cryosphere and land surfaces. The climate is depicted through a three-dimensional grid laid over the earth. Intergovernmental Panel on Climate Change, “What is a GCM?”, online: <www.ipcc-data.org/guidelines/pages/gcm_guide.html>. See also B Geerts & E Linacre, “What are General Circulation Models?”, online: University of Wyoming <www.as.uwyo.edu/~geerts/cwx/notes/chap12/nwp_gcm.html>.


Third, a geoengineering HRIA should include an ex ante deliberative process between rights-holders and duty-bearers that would help identify specific concerns of rights-holders and duty-bearers.

A critical sine qua non of the legitimacy of any potential governance architecture for climate geoengineering is engagement of populations in regions where impacts are likely to be most extreme, especially in developing countries. This participatory component of the HRIA process could help to facilitate this by operationalizing procedurally oriented human rights provisions, including the right to information and the right to public participation.

The right to access pertinent information is critical for members of potentially affected publics to be heard and to potentially influence decision-making processes.

The generalized right of access to information by the public is recognized in the UDHR, as well as in the ICCPR. Moreover, there is support in a number of instruments for the more particularized right of access to information about environmental and climate matters, including in the UNFCCC, the Paris Agreement, and the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters. The UN special rapporteur for human rights and the environment has also stated that “in order to protect human rights from infringement through environmental harm, States should provide access to environmental information and provide for the assessment of environmental impacts that may interfere with the enjoyment of human rights.”

The right to public participation is provided for in the UDHR, as well as in many other human rights instruments. It is also recognized in pertinent environmental instruments, including the UNFCCC, the Paris Agreement, the World Charter for Nature and the Aarhus Convention.

In developing this component of the HRIA, every effort should be made to go beyond merely soliciting public opinion on geoengineering issues, usually characterized as public communication or public consultation, to the establishment of large-scale public deliberative processes. Public deliberative processes seek to afford citizens, or a representative subset thereof, the opportunity to discuss, exchange arguments and deliberate on critical issues, as well as to seek to persuade one another of the judiciousness of their solutions. Public deliberative processes emphasize the role of debate and discussion to facilitate the formulation of well-informed opinion and a reflexive process whereby participants are open to revision of their opinions based upon their interaction with others.


32 UNHRC, supra note 9 at 15.

33 UDHR, supra note 235, art 19.

34 ICCPR, supra note 219, art 19.

35 UNFCCC, supra note 2, art 6(a)(ii).

36 Paris Agreement, supra note 7, art 12.

37 Aarhus Convention, supra note 317, arts 3(2), 6.

38 “In public communication, information is conveyed from the sponsors of the initiative to the public.... In public consultation, information is conveyed from members of the public to the sponsors of the initiative, following a process initiated by the sponsor. Significantly, no formal dialogue exists between individual members of the public and sponsors. The information elicited from the public is believed to represent currently held opinions on the topic in question.” Gene Rowe & Lynn J Frewer, “A Typology of Public Engagement Mechanisms” (2005) 30 Sci, Tech & Hum Values 251 at 254–55, online: <web.iainirebon.ac.id/ebook/moon/CivilSociety/A Typology%20of%20Public%20Engagement%20Mechanisms.pdf>.


40 UDHR, supra note 235, art 21.
such “deliberation is not so much a form of discourse or argumentation as a joint, cooperative activity.”

The format of deliberative exercises can facilitate critical scrutiny of pre-analytic assumptions underpinning our framing of data and other sources of knowledge, and can foster self-awareness and reflection by key actors, including science and policy institutions. This can both enhance the quality of the problem-solving and decision-making process, as well as bolster the legitimacy of policy decisions.

Such a reflexive process, if conducted at regional and/or national scales, might help society “steer clear of the pitfalls of a grand narrative, as it would manifest differently in different cultures and ecosystems.” This would open up the possibility of developing a suite of geoengineering approaches, each of which are most attuned to the needs of individual countries or regions, such as SAI in the Arctic or marine cloud brightening in the northeast Pacific.

Fourth, a geoengineering HRIA should include analysis and recommendations. This element of the HRIA process should include assessment of the human rights impacts of the proposed geoengineering intervention (research or deployment), and an assessment of state responsibilities to respect, protect and fulfill human rights in this context. This step should also include the critical element of the development of recommendations to avoid or ameliorate potential impacts on human rights or alternative means to achieve climatic goals that would avoid human rights violations. This obligation of outlining and discussing mitigation and alternative options is also an important component of environmental impact assessments at both the international and national levels.

For example, many proponents contend that SRM climate geoengineering options might need to be deployed to respond to “climate emergencies.” The most frequently cited scenarios are those in which there is the imminent threat of temperatures exceeding critical climatic thresholds, manifesting themselves, for example, in a dramatic increase in the decay rate of large ice sheets, widespread bleaching of coral reefs or other abrupt and potentially non-linear changes in the climate system. However, there may also be alternatives to climate geoengineering that can help us avoid passing critical thresholds as we make a transition to a decarbonized world economy without threatening human rights. For example, a recent study by the UNEP and the WMO concluded that implementation of a full set of measures to reduce


331 Burns, supra note 23 at 268, 269.


333 Ibid.


black carbon and tropospheric ozone emissions by 2030 could reduce the potential increase in global temperature projected for 2050 by 50 percent, with substantial net economic benefits. This would translate into a reduction of temperatures by 0.5°C globally by 2050, and 0.7°C in the Arctic by 2040. In the latter context, that would offset all, or a substantial portion, of the reference warming scenario of 0.7°C to 1.7°C by 2040. Moreover, these policy measures would yield substantial co-benefits, including the avoidance of more than two million premature deaths and the annual loss of one to four percent of global production of maize, rice, soybeans and wheat. An HRIA process might help to ensure that such options are thoroughly vetted.

Alternatively, an HRIA process might lead the world community to opt for a strictly limited application of geoengineering options concordant with protection of human rights. For example, SRM approaches could be used simply to facilitate “peak shaving.” Peak shaving would entail limited deployment of SRM technologies to ameliorate the worst potential impacts of peak GHG emissions, while mandating an ambitious program of mitigation and adaptation. By illustration, Michael Zürn and Stefan Schäfer suggested limiting alteration of the radiation balance to no more than 1 W/m² as a means to greatly reduce the potential negative side effects of SRM deployment. Similar scenarios have been advanced by Douglas G. MacMartin, Ken Caldeira and David W. Keith and Takano Kousugi. Similar standards might be established for CDR options.

ASSESSMENT OF CAPACITIES AND STRATEGIES TO BOLSTER CAPACITIES

Capacity, broadly defined, is a critical consideration in determining the ability of duty-bearers to meet their obligations and rights-holders to claim their rights. In terms of duty-bearers, an HRBA in the context of climate

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341 Ibid.


343 Horton, supra note 336 at 150.


345 Douglas G MacMartin, Ken Caldeira & David W. Keith, “Solar Geoengineering to Limit the Rate of Temperature Change” (2014) 372 Science 672 at 672. For example, SRM approaches could be geoengineering options concordant with protection of human rights. For example, SRM approaches could be used simply to facilitate “peak shaving.” Peak shaving would entail limited deployment of SRM technologies to ameliorate the worst potential impacts of peak GHG emissions, while mandating an ambitious program of mitigation and adaptation. By illustration, Michael Zürn and Stefan Schäfer suggested limiting alteration of the radiation balance to no more than 1 W/m² as a means to greatly reduce the potential negative side effects of SRM deployment. Similar scenarios have been advanced by Douglas G. MacMartin, Ken Caldeira and David W. Keith and Takano Kousugi. Similar standards might be established for CDR options.

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341 Ibid.


343 Horton, supra note 336 at 150.


geoengineering should include an assessment of human resources, most specifically, the capacity to recognize and understand the human rights implications of deployment of potential geoengineering technologies. It should also include an assessment of the economic resources of duty-holders, with an eye to ensuring safe deployment of technologies, the capability for effective monitoring and the capability to compensate those who might experience contravention of their human rights.

In terms of rights-holders, an HRBA assessment of capacity should include the determination of rights-holders’ access to pertinent information, particularly for marginalized and traditionally excluded groups, and assessment of their capabilities to organize and participate in deliberative forums related to climate geoengineering and to obtain redress for violations.348 Both duty-bearers and rights-holders should subsequently focus on developing strategies to strengthen capacities, including through provision of financial resources, training of personnel and pertinent scientific research.

**ESTABLISHMENT OF MONITORING AND EVALUATION PROGRAMS**

Implementation of monitoring programs should include the use of a *role and capacity analysis* to assess the obligations of institutions at the international and national level to monitor the impacts of geoengineering, as well as their capacity, and an *analysis of existing information systems and networks* to assess critical information gaps for effective monitoring by decision makers, rights-holders and rights-bearers.349

One example where monitoring could be particularly salutary is in terms of deployment of BECCS. Projections of potentially sustainable levels of bioenergy deployment are “systematically optimistic” and are not based on empirical observations or practical experience.350 Raphael Slade, Ausilio Bauen and Robert Gross suggest fostering “learning by doing” through close monitoring of incremental efforts to expand the role of biomass in energy production.”351 Close monitoring of the first few exajoules of energy crops would help us realistically assess purported benefits of integrated crop and energy production and the sustainability of energy crop extension into allegedly marginalized, degraded and deforested lands.

**COLLABORATION WITH HUMAN RIGHTS BODIES**

The UNFCCC would clearly benefit from collaboration with human rights bodies. This could include UN bodies, such as: the OHCHR and the UNHRC; human rights treaty bodies, such as the Human Rights Committee, which monitors implementation of the ICCPR by its parties, and the Committee on the Rights of the Child; regional bodies, such as the Inter-American Commission on Human Rights and the African Commission on Human and People’s Rights; and non-governmental organizations, such as Human Rights Watch and the International Red Cross. Collaboration should also be explored with other organizations that may help to inform the process, such as the Global Bioenergy Partnership (GBEP), comprised of both state and non-state actors. The GBEP has developed a set of sustainability indicators intended to inform decision making and to foster sustainability, including in the context of socio-economic considerations.352

Moreover, the OHCHR has called for integrating an HRBA into climate change mitigation and adaptation policies.353 Thus, the parties to the Paris Agreement could likely call upon the OHCHR, as well as on other human rights agencies and organizations, for assistance in development of the HRBA.354 Human rights institutions could also help fill in interstices by utilizing the HRBA’s mechanisms for investigating human rights issues, including special procedures, the establishment of special advisory committees and universal periodic review.355

**Implementing the HRBA for Climate Geoengineering within the Paris Agreement**

The optimal method to facilitate the HRBA process under the Paris Agreement would be to establish a human

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350 Slade, Bauen & Gross, *supra* note 196 at 103.

rights subsidiary body comprised of human rights and development experts. This body could be tasked, inter alia, with developing HRBA architecture, advising the COP on relevant human rights standards and reporting on best national practices.\(^\text{356}\) Alternatively, the most appropriate current institutions for operationalizing the HRBA process under the Paris Agreement would be its Subsidiary Body for Implementation (SBI) and Subsidiary Body for Scientific and Technological Advice (SBSTA). The SBI was established under the UNFCCC to assist the parties “in the assessment and review of the effective implementation of the Convention.”\(^\text{357}\) The SBSTA was established in the UNFCCC “to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely information and advice on scientific and technological matters relating to the Convention,”\(^\text{358}\) including “scientific assessments on the effects of measures taken in the implementation of the Convention.”\(^\text{359}\) The SBI has been designated in both the Kyoto Protocol and the Paris Agreement to fulfill the same functions,\(^\text{360}\) as has the SBSTA.\(^\text{361}\)

At COP17, the parties to the UNFCCC established a “forum on the impact of the implementation of response measures,” which was mandated to meet twice annually under the rubric of the SBI and SBSTA.\(^\text{362}\) The forum is tasked, inter alia, with assessment of the impacts of climate response measures and engendering cooperation on response strategies.\(^\text{363}\) At COP21 in Paris, the parties decided to extend the mandate of the forum, and to strengthen it, by, inter alia, enhancing the capacity of the parties to deal with the impact of implementation of response measures and establishment of ad hoc technical expert groups.\(^\text{364}\)

The forum would be an appropriate body to conduct an HRBA on behalf of the parties to the Paris Agreement or the Kyoto Protocol. It could establish an ad hoc technical expert group with expertise in both the technological aspects of geoengineering and in the field of human rights law.\(^\text{365}\) As indicated above, it could also seek assistance from the OHCHR and other human rights bodies in terms of human rights considerations.\(^\text{366}\)

To further strengthen accountability, the parties could require that the transparency mechanisms of the Paris Agreement,\(^\text{367}\) comprised of national communications and biennial reports, contain a section on how human rights are being integrated into climate change response measures. Non-state actors could also be invited to supplement these reports in this context, reflecting the Universal Periodic Review process under the auspices of the UNHRC.\(^\text{368}\) Moreover, the parties to the agreement could also consider establishing a formal grievance mechanism to provide another avenue for potentially affected parties to seek accountability. Models for such a mechanism might include the International Finance Corporation’s Compliance Advisor Ombudsman or the UNDP’s Compliance Review and Grievance Process.\(^\text{369}\)

As Stephen M. Gardiner concludes, “To exert control over the planetary system is to determine the basic life prospects of humans within that system, including the parameters against which they pursue their conceptions of the good, generate their ideals, and even conceive of their identities.”\(^\text{370}\) While one should not overemphasize the potential effectiveness of an HRBA process in the context of climate geoengineering, it might ultimately imbue the world’s most vulnerable people with some measure of agency in what would constitute a truly momentous decision.

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357 UNFCCC, supra note 2, art 10(1).

358 Ibid, art 9(1).

359 Ibid, art 9(2)(b).

360 Kyoto Protocol, supra note 3 at art 15(1); Paris Agreement, supra note 7 at art 18(1).

361 Ibid.

362 UNFCCC, “Forum on the impact of the implementation of response measures”, online: <unfccc.int/cooperation_support/response_measures/items/7418.php>.

363 Ibid.


365 Center for International Environmental Law, supra note 355 at 29.

366 See note 354 and accompanying text. Another alternative would be to establish an expert group on human rights. While such groups are composed of experts acting in their personal capacity and don’t have the same status as the official Subsidiary Bodies of the UNFCCC, they could provide the parties with some guidance, as does the least developed countries (LDCs) Expert Group, which supports developing countries in the preparation of their National Adaptation Programs of Action. UNFCCC, LDC Expert Group, online: <unfccc.int/adaptation/groups_commitees/ldc_expert_group/items/4727.php>.

367 Paris Agreement, supra note 7, art 13(4).

368 Mary Robinson Foundation, supra note 1 at 7.


Challenges to Implementing an HRBA in the Context of Climate Geoengineering

EXTRATERRITORIAL APPLICATION OF HUMAN RIGHTS

A state that would make the decision, for example, to allocate land for BECCS’ feedstock or to deploy an SRM option would have an obligation to respect, protect and fulfill the human rights of its nationals. However, it is quite likely that deployment of many climate geoengineering options would have ramifications well beyond the borders of any country. Thus, a pertinent question is whether a state’s obligations under international human rights law extend to individuals that are not within a state’s territory or effective control. This is usually referred to as the question of “extraterritorial” application of human rights principles. This is obviously an extremely important question given the large number of circumstances under which deployment of geoengineering might have transboundary impacts, with the duty-bearers and rights-holders potentially separated by thousands of miles.

As Marc Limon observed, “existing human rights law is primarily concerned with how a government treats its own citizens and others within its territory or under its jurisdiction.” This is the “vertical” duty of a state in terms of human rights. Imposition of so-called “diagonal” or extraterritorial duties is a far closer case from a legal perspective. However, a reasonable case can be made for this proposition and, thus, by extension, an application of a human rights-based approach extraterritorially.

It is pertinent to initially examine relevant provisions of key human rights instruments. The UDHR contains no language limiting its jurisdiction to protection of the human rights of nationals. In fact, there is a suggestion of extraterritorial scope, as it provides that “no State, group or person” has a right to contravene rights outlined in the declaration. The ICESCR also contains no jurisdictional limits and, in fact, obliges states to take steps “individually and through international assistance and co-operation” to achieve full realization of the rights contained in the treaty. The Committee on Economic, Social and Cultural Rights, which monitors implementation of the ICESCR, has recognized a number of obligations with extraterritorial effect. These include respecting the right to enjoyment of the right to food in other countries by refraining from the imposition of food embargoes and operationalizing the requirement of assistance by providing food aid when required, as well as international cooperation to achieve the full realization of the right to health. The American Declaration of the Rights and Duties of Man similarly provides that “[t]he international protection of the rights of man should be the principle guide of an evolving American law.” The Committee on the Rights of the Child has argued that parties to human rights conventions have obligations both to implement them within their jurisdictions as well as contribute to global implementation through international cooperation, although it does not specify the nature of this cooperation.

On the other hand, the ICCPR could be construed as precluding extraterritorial application of its mandates, providing that state parties are to “respect and to ensure to all individuals within its territory and subject to its jurisdiction the rights recognized in the present Covenant.” However, some commentators have suggested that this provision could be read disjunctively, with parties thus being required to respect the rights set forth in the covenant without territorial limitation, while preventing and redressing rights violations within their jurisdictions.

Several provisions of the United Nations Charter also support the proposition that states have extraterritorial

377 UDHR, supra note 235, art 30.
378 ICESCR, supra note 220, art 2(1) [emphasis added].
379 General Comment 12, supra note 255 at paras 36–42.
380 General Comment 14, supra note 262 at para 39.
381 American Declaration of the Rights and Duties of Man, supra note 227 at Preamble [emphasis added].
383 ICCPR, supra note 219, art 2(1) [emphasis added].
human rights obligations. Article 55 of the Charter provides for UN promotion of “universal respect for, and observance of, human rights,” and article 56 mandates that member states “take joint and separate action” to achieve this purpose.

In 2011, 40 international law experts from around the world adopted the Maastricht Principles on Extraterritorial Obligations in the Area of Economic, Social and Political Rights. The principles were intended to serve as a clarification of extraterritorial legal obligations in terms of existing international law. The principles provide, inter alia, that all states “have obligations to respect, protect and fulfill human rights...both within their territories and extraterritorially.” The principles further conclude that a state has human rights obligations not only in situations over which it exerts “authority or effective control,” but also in “situations over which State acts or omissions bring about foreseeable effects on the enjoyment of economic, social and cultural rights, whether inside or outside its territory,” or “situations in which the State, acting separately or jointly...is in a position to exercise decisive influence or to take measures to realize economic, social and cultural rights extraterritorially.”

Assuming that extraterritorial human rights obligations can be established, how would we construe their scope in the context of climate geoengineering? A reasonable approach is to examine the scope of the duties to respect, protect and fulfill at the international level. The duty to respect in an extraterritorial context requires that states “avoid measures that hinder or prevent the enjoyment of...rights in another state.” Thus, states deploying geoengineering technologies would be required to avoid options that might undermine the exercise of human rights in other countries, such as approaches that might reduce food production or deplete the ozone layer, potentially imperilling the right to health in non-deploying states.

The extraterritorial duty to protect has two components. First, states must take into account human rights in terms of negotiation and implementation of treaties or when entering into multilateral or bilateral obligations. Second, states must take measures to ensure that non-state entities within their jurisdictions do not interfere with the enjoyment of rights in other countries. Thus, in the context of climate geoengineering, this would require states to take into account human rights obligations in treaty regimes of which they are parties, as well as in multilateral or bilateral collaborations. This should include ensuring an inclusive process that engages all potentially affected parties and affords them meaningful opportunities for consultation.

The duty to fulfill is controversial in the international context because of its emphasis on the need to take positive state action in other nations. However, there is increasing recognition of the international human rights obligation to fulfill as a secondary or subsidiary duty should measures taken to respect or protect prove insufficient.

**SHOULD CLIMATE GEOENGINEERING AND HUMAN RIGHTS BE VIEWED FROM A COMPARATIVE HUMAN RIGHTS PERSPECTIVE?**

Some commentators have contended that deployment of climate geoengineering options may ultimately prove to be compelling despite their risks because the spectre of steadily rising emissions and associated climatic impacts could constitute a more imposing global risk.

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386 Ibid, art 56. See also ibid, art 1(3). Among the purposes of the United Nations are “to achieve international cooperation...in promoting and encouraging respect for human rights...”


388 Ibid, s I.3.

389 Ibid, s II.9(a).

390 Ibid, s II.9(b).

391 Ibid, s II.9(c).


395 Carmona, supra note 394 at 91.

396 Mok, supra note 392 at 76.


398 Bullis, supra note 139; Owen, supra note 16 at 214.
By extension, it might be argued that the human rights violations associated with climate change under current trajectories might “trump” those of climate geoengineering.

David Morrow and Toby Svoboda have developed an analytical framework, premised on principles of justice, that can help guide societal choices between “non-ideal” policy options. These are choices that must be made under conditions of “imperfectly just circumstances.”

They argue that climate geoengineering and current trends in climate change constitute a non-ideal policy environment, with society’s “less than ideal response to the threat of climate change” leading many to advocate for climate geoengineering, despite the risks that it could also impose. Geoengineering, Svoboda argues in another piece, “may do better than emissions mitigation or adaptation alone when it comes to serving both overall welfare and incomplete fairness.”

However, Morrow and Svoboda also propose two criteria that must be met to justify a “non-ideal” policy option such as geoengineering: “a proportionality criterion,” which “compares the prima facie wrongs that a non-ideal policy inflicts with the injustice that it alleviates;” and a “comparative criterion,” which “compares a proposed non-ideal policy with other politically feasible alternatives.”

The HRBA developed in this report could play an important role in conducting such an analysis. It could help society to compare the human rights implications of the impacts of climate change and geoengineering as a way of operationalizing the concept of “prima facie wrongs.” Moreover, it would provide one set of metrics, to be utilized in conjunction with others in the realms of economics and environmental considerations, to compare geoengineering with policy alternatives. As indicated above, this might include alternatives such as aggressive efforts to reduce black carbon as a mechanism to slow down rates of warming and give us more “space” to decarbonize the economy, as well as efforts to substantially accelerate the path to transformation of our economy to one based on “winds, water and sunlight” by 2050. As Gardiner has observed, even in the face of frightening climatic scenarios, we should not assume that climate geoengineering is the “lesser evil” until we have thoroughly vetted all mitigation and adaptation options.

CONCLUSIONS

The Paris Agreement provides a framework for taking human rights into account in responding to climate change. This paper has sought to outline a framework for operationalizing this broad mandate in the context of climate geoengineering.

It is hoped that this framework might also prove helpful in assessing the human rights implications of mitigation and adaptation options. To date, consideration of the human rights implications of adaptation responses has been “peripheral.” Some adaptation strategies, such as forced assimilation of indigenous peoples for compelled migration, may raise severe human rights questions that should be addressed by the parties to the Paris Agreement. In the context of adaptation responses, an HRBA could also be a salutary mechanism to avoid so-called “negative lock-ins,” that is, approaches that undermine the ability of the system to respond to larger subsequent impacts. The focus in human rights analyses on the root causes of vulnerability would help to avoid sclerotic adaptive responses. Similar concerns have been raised in the context of mitigation responses, including the

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408 Fisher, supra note 298 at 13.
Clean Development Mechanism of the Kyoto Protocol\(^{409}\) and efforts to reduce deforestation (REDD+).\(^{410}\)

The Paris Agreement may ultimately be viewed as a major breakthrough in the field of climate policy making, as well as a powerful force for defending the human rights of the most vulnerable in our society from environmental change. The emerging field of climate geoengineering affords us an opportunity to develop a framework to make human rights more than merely an aspiration in the context of climate policy making.

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